(12) UK Patent Application (19) GB (11) 2 197 910 (13) A

(43) Application published 2 Jun 1988

(21) Application No 8628346

(22) Date of filing 27 Nov 1986

(71) Applicant
Emilia Orian
17 Ravina Street,
Tel Aviv,
Israel

(72) Inventor
Michael Brawerman (Deceased)

(74) Agent and/or Address for Service
Baron & Warren
18 South End,
Kensington,
London, W8 5BU

(51) INT CL[4]
F02C 7/00

(52) Domestic classification (Edition J):
F1G 2 5C3B 5C4 9

(56) Documents cited
GB 1540963 GB 1534499 GB 1533515
GB 1485228 GB 1431016 GB 1240662
"The Jet Engine" Rolls Royce Ltd, July 1969 (3rd Edition)
"Aircraft Gas Turbine Technology" by Irwin E. Treager (2nd Edition) 1979

(58) Field of search
F1G

(54) Modular gas turbine plant

(57) A method of producing a gas turbine comprises prefabricating modules of the constituent parts of the gas turbine and assembling such modules by inter-connecting them with conduits which suit the needs of the assembly and the purpose of the turbine.

In one embodiment, in which the turbine is to be used as a hot gas generator, the turbine comprises a turbo module having an air inlet (110), and a compressor outlet (112) connected via conduits and a starting module (111) to the inlet (113) of a combustion module. The outlet of the combustion module is connected via conduit (118) to the turbine inlet of the turbo module. The hot air and combustion products from the combustion module drive the turbine wheel of the turbo module which in turn drives the compressor wheel of the turbo module. The hot air and combustion products also flow to an auxiliary mixing module (124) where they are conditioned in accordance with commands from a control module.

Details of the various components are also disclosed.

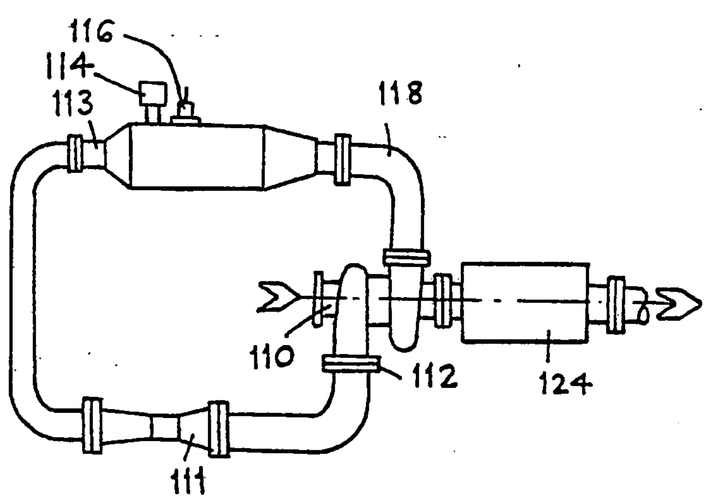


FIG.10

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

GB 2 197 910 A

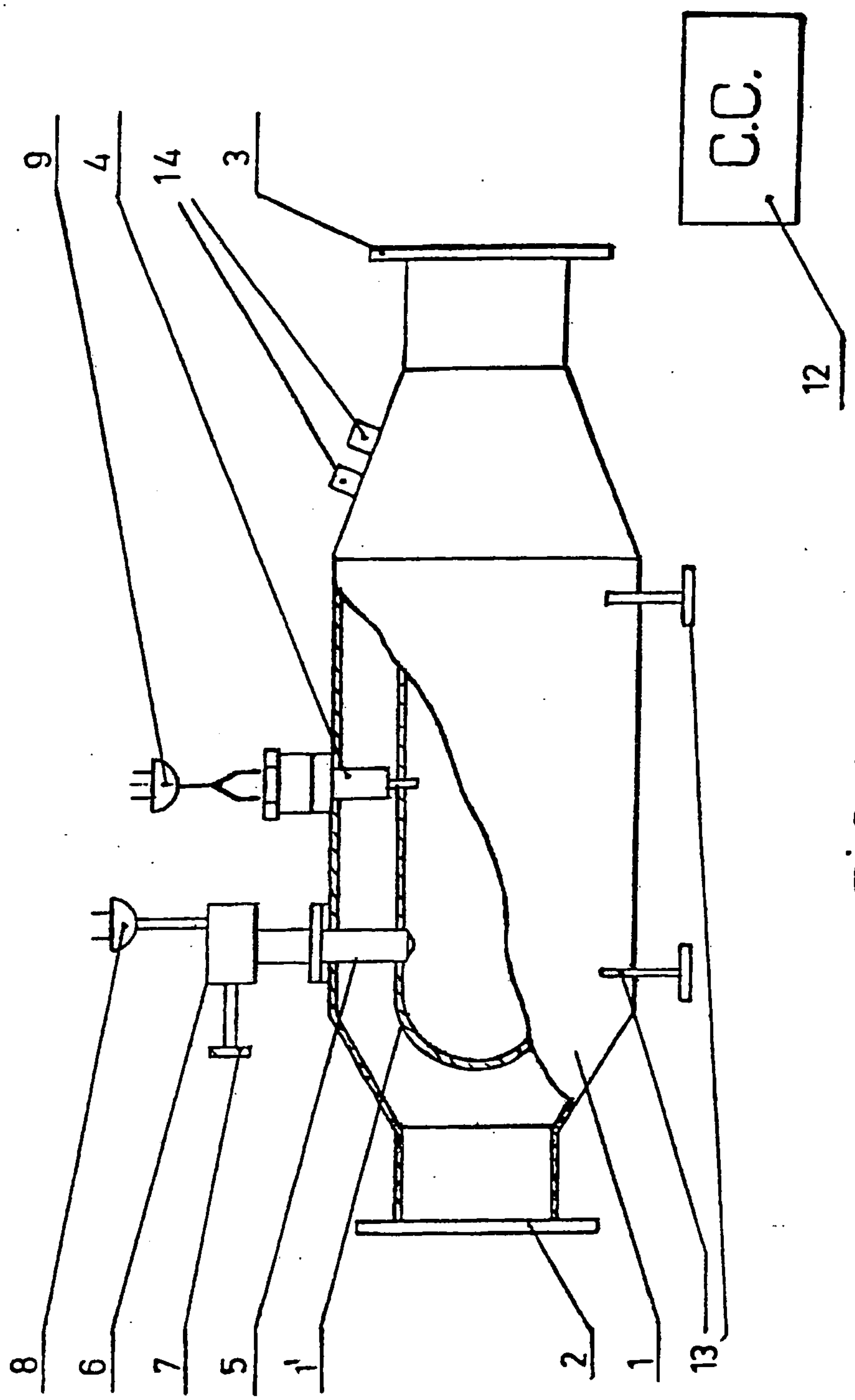


FIG 1

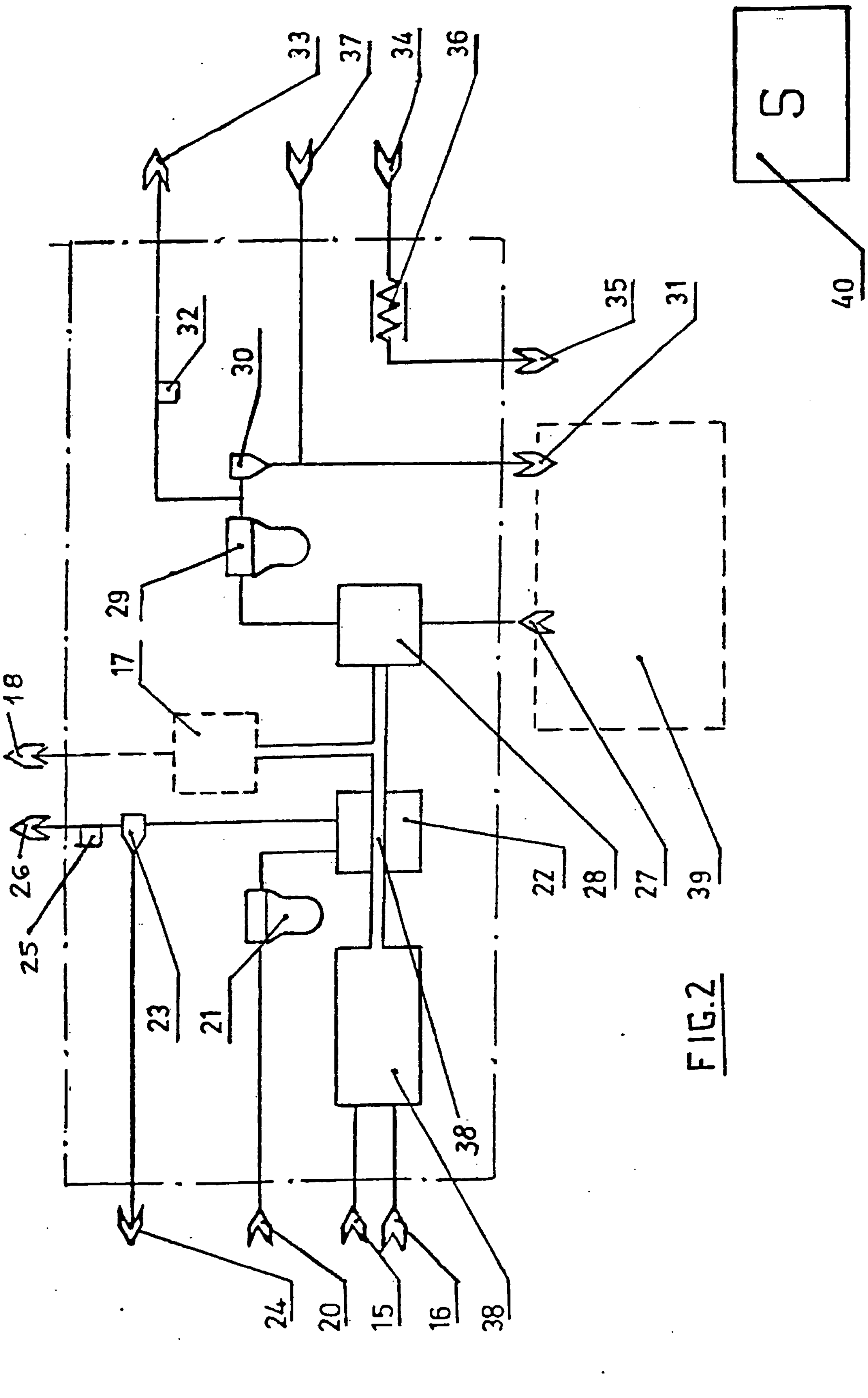

33
37
34
36
S
40
32
30
35
31
29
17
18
26
25
23
21
22
28
27
39
38
24
20
15
16
38

FIG.2

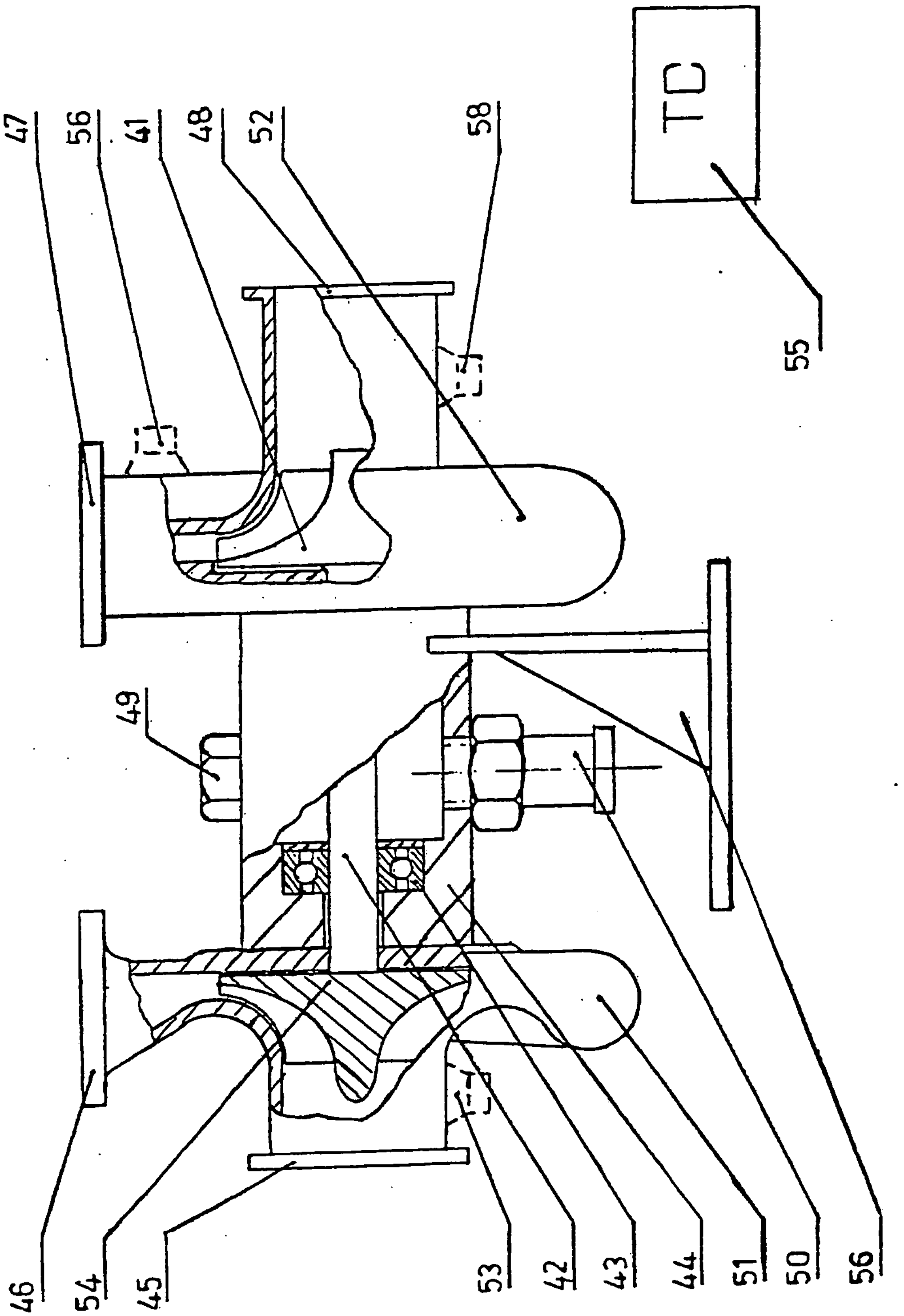


FIG 3

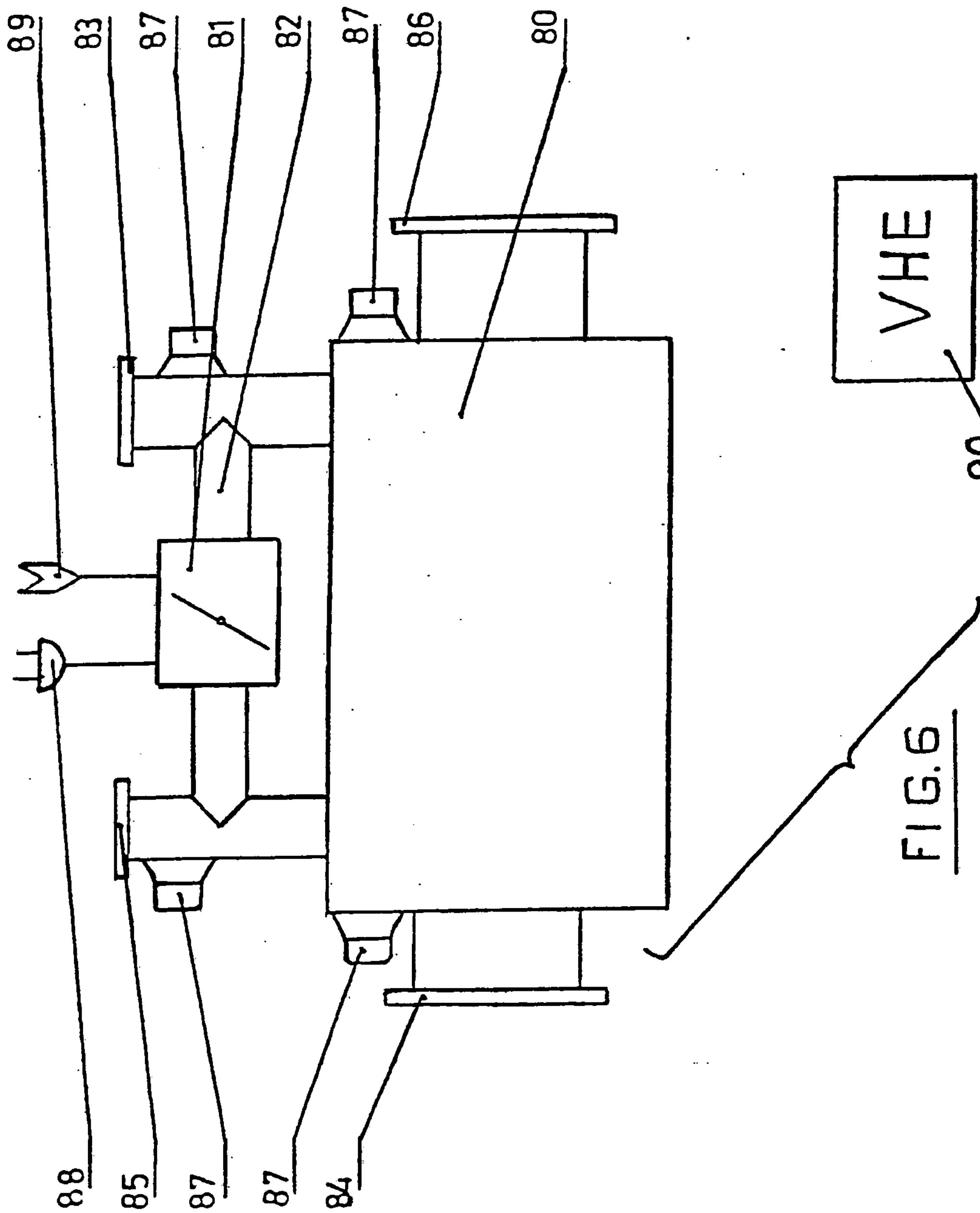


FIG.6

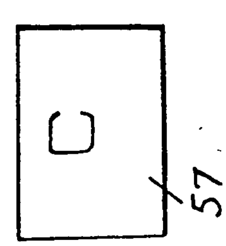


FIG.4

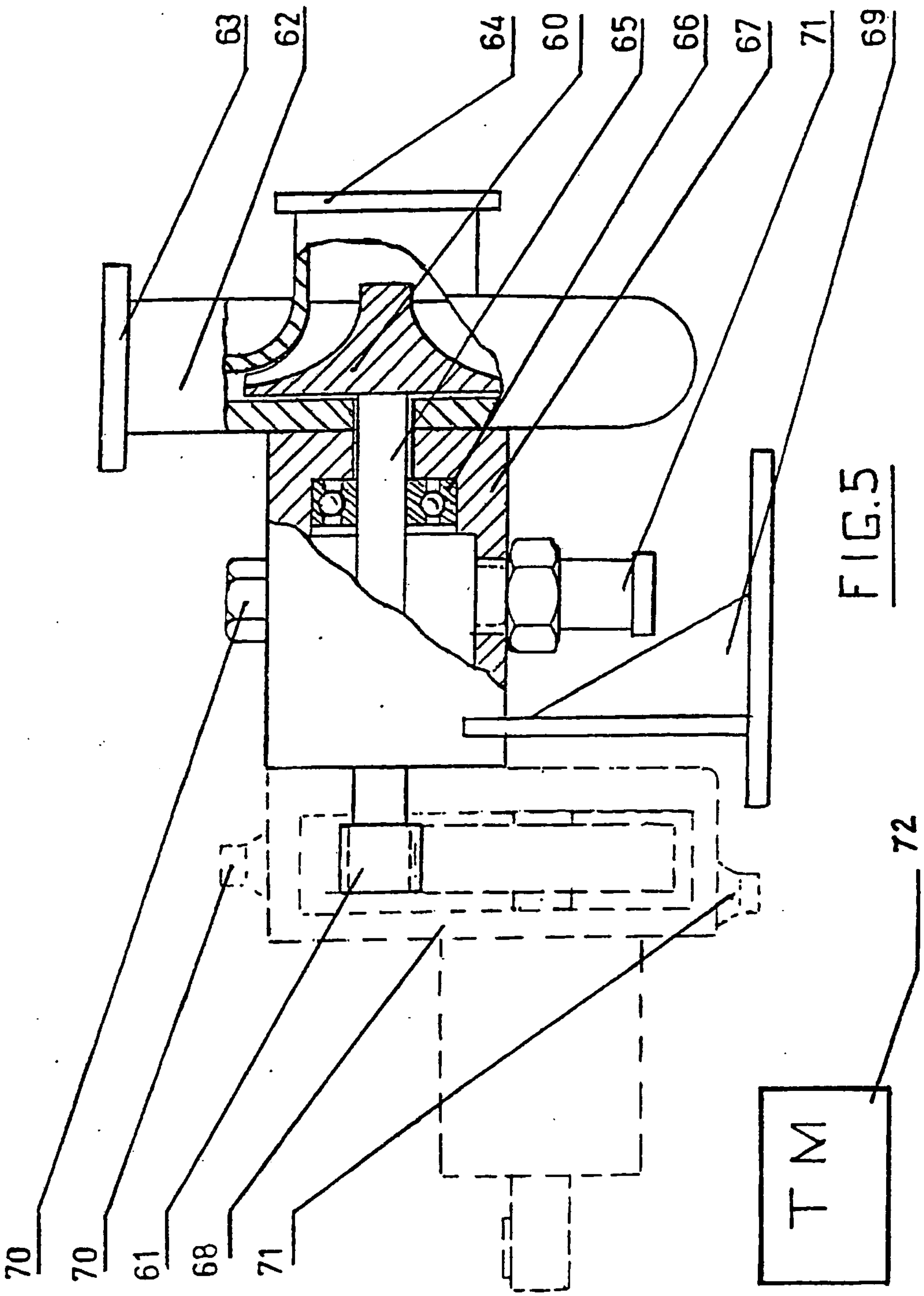


FIG.5

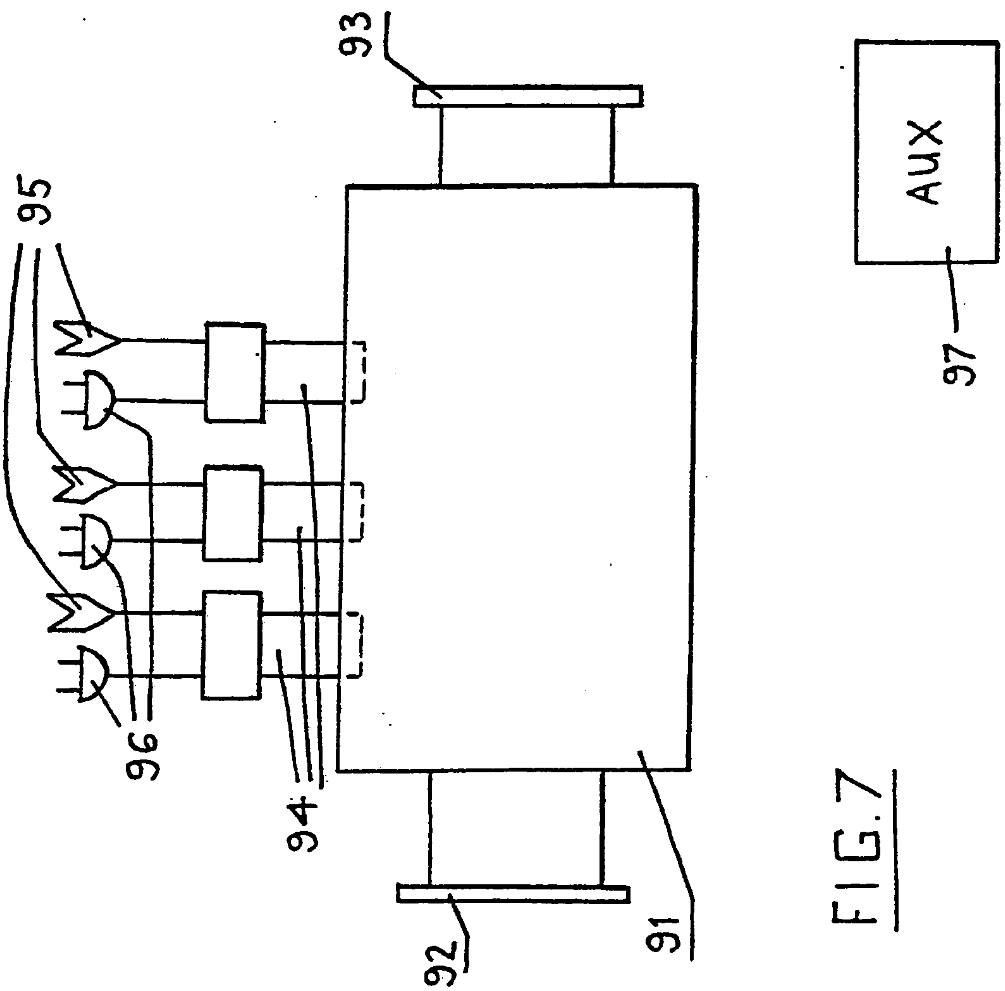


FIG.7

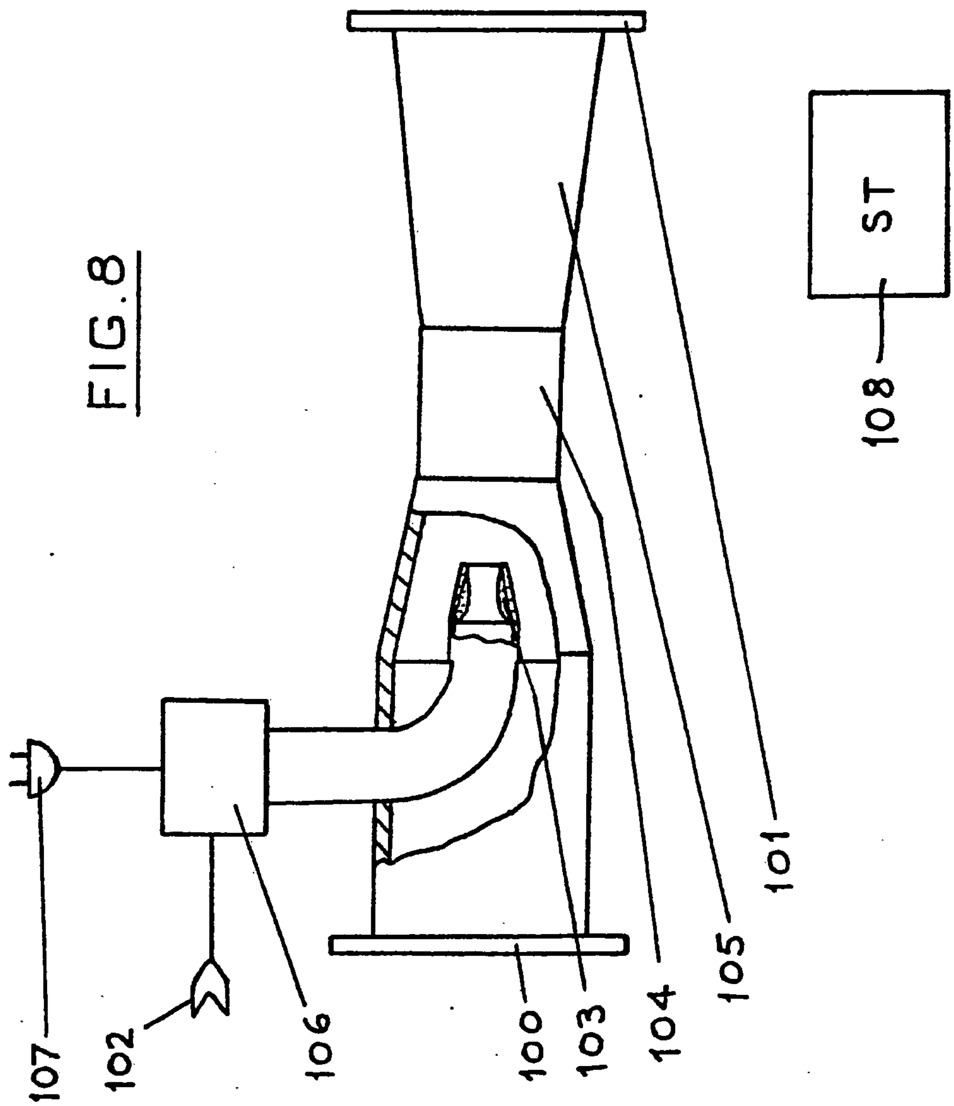


FIG. 8

LIST OF BASIC CONNECTORS AND THEIR SCHEMATIC DESCRIPTION

DESCRIPTION OF CONNECTOR	SCHEMATIC DESCRIPTION
1 PNEUMATIC CONNECTOR PIPE TUBE FLEXIBLE HOSE	______A______A______A___
2 HYDRAULIC CONNECTOR PIPE TUBE FLEXIBLE HOSE	_____ H______H _____H___
3 FUEL CONNECTOR PIPE TUBE FLEXIBLE HOSE	______F______F______F___
4 ELECTRICAL POWER CONNECTOR WIRE CABLE	______W______W______W___
5 COMMAND CONNECTOR ELECTRICAL PNEUMATICAL HYDRAULIC SIGNALS AND COMMAND	______C______C______C___
6 OIL AND LUBRICANT CONNECTOR PIPE TUBE FLEXIBLE HOSE	______L______L______L___
7 MECHANICAL CONNECTOR SHAFTS FLEXIBLE SHAFTS BELTS GEARS	______E_____E ______E___

FIG. 9

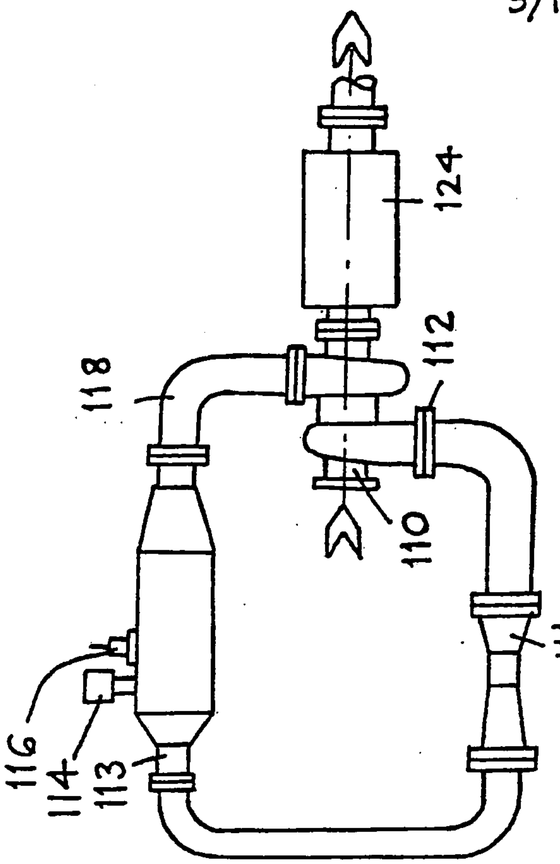


FIG.10

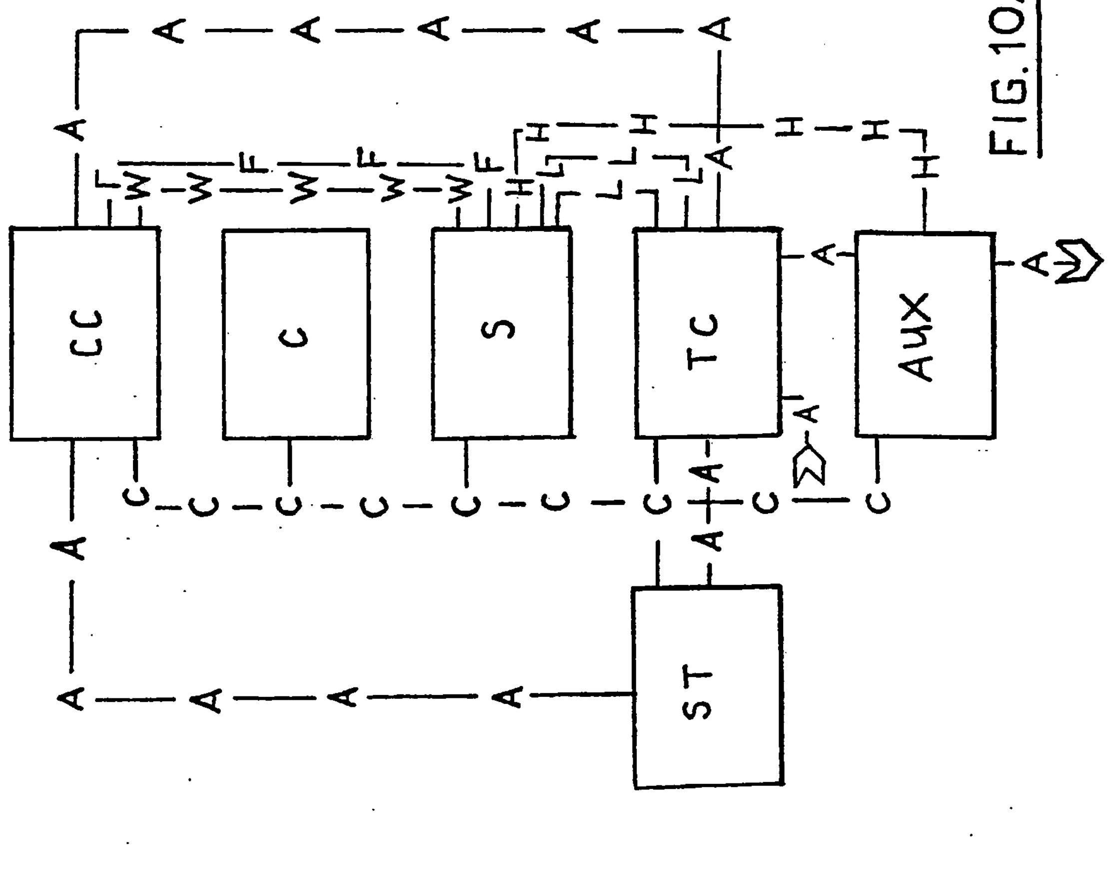
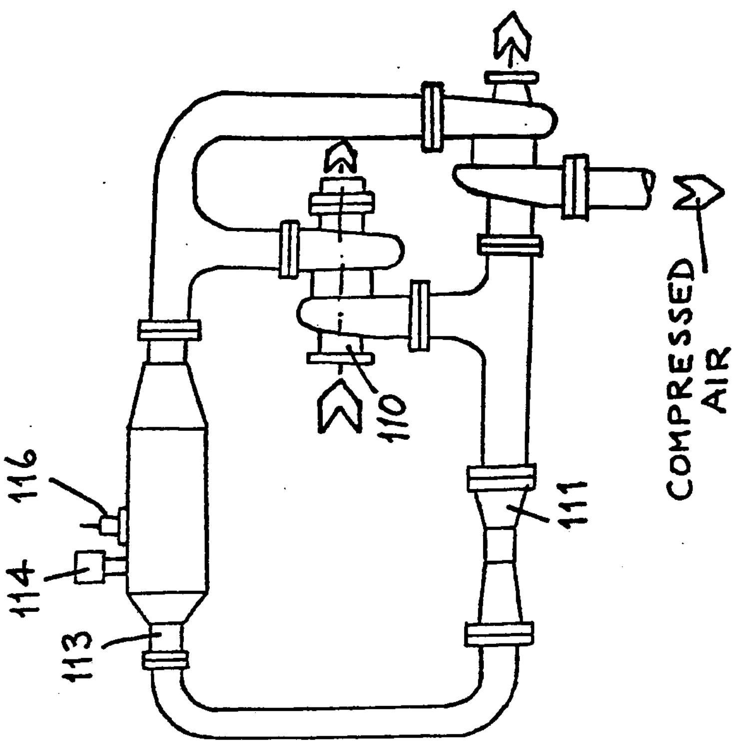


FIG.10A


116
114
113
110
111
COMPRESSED AIR

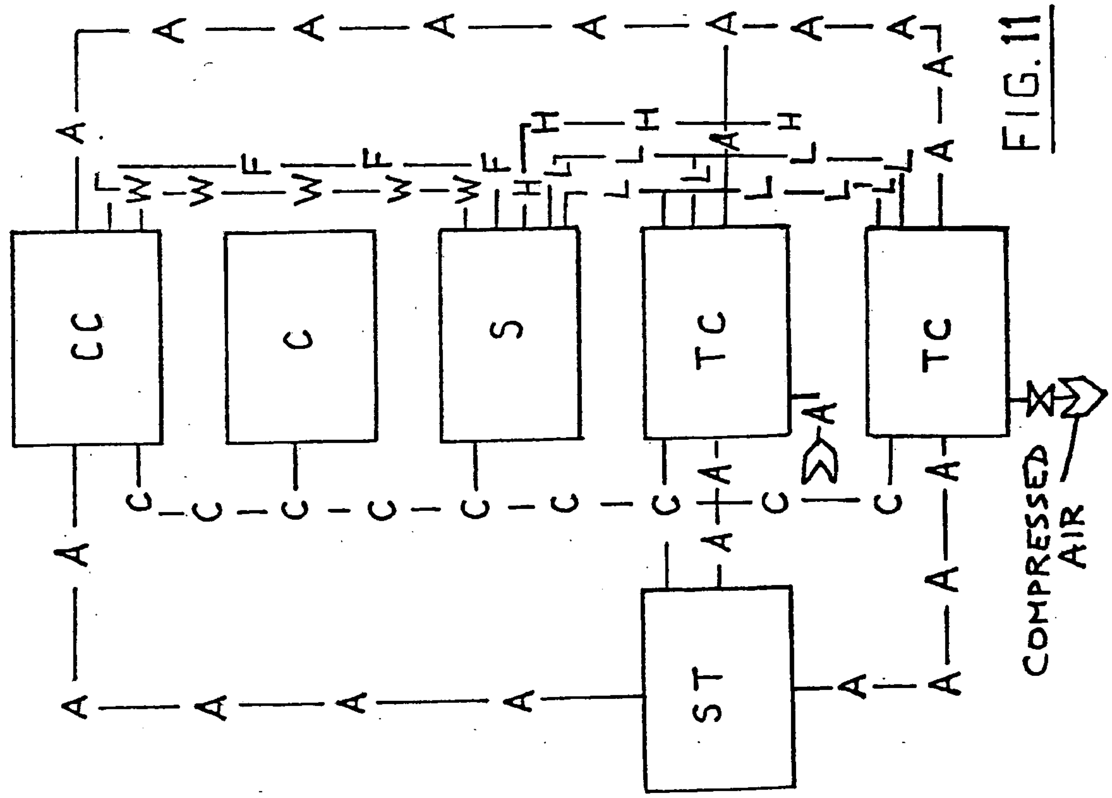
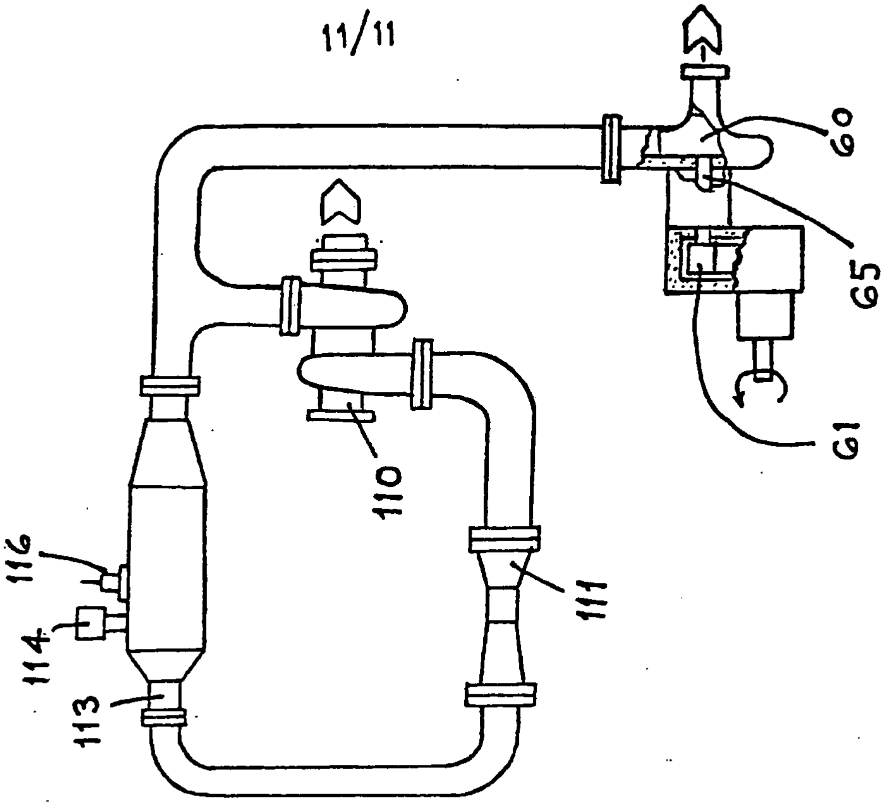

CC
C
S
TC
TC
ST
A
W
F
H
L
C
COMPRESSED AIR

FIG.11



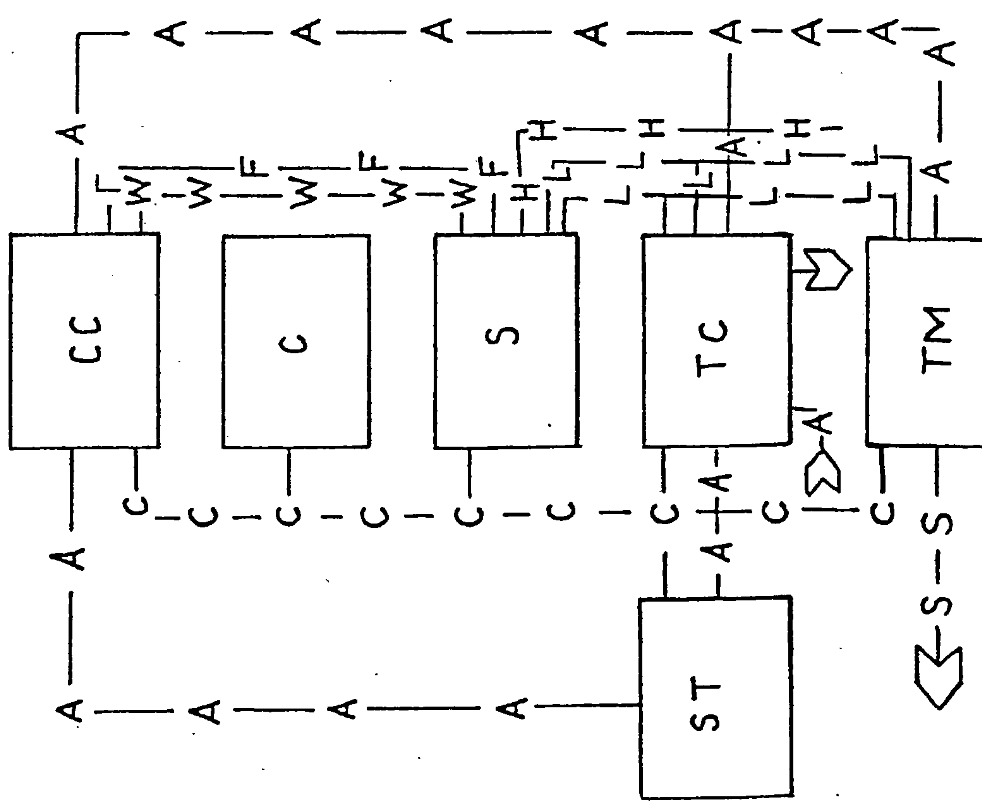


FIG.12

GAS TURBINE

FIELD OF INVENTION

The present invention relates to gas turbines and especially to small gas turbines for generating hot gasses, compressed air, power, or any combination of them for either industrial, agricultural, civil engineering or emergency applications.

Gas turbine machines have many forms and applications. The two most popular and known are turbo-jet engines and the type of turbine engines that supply mechanical power. These turbine engines are built today mainly for aeronautical and military applications, and therefore designed to very high standards and are produced only in relatively small series.

As a result of this situation turbine engines are so highly priced that they are prohibitive for most civilian and industrial markets. Accordingly at present there is no extensive usage of turbines in civilian installations, apart from a few back up and emergency turbine generators in power stations. In the below 100 HP size, for which the military has almost no use, there is an acute lack of gas turbines and it is in this range of size that civilian applications would be desirable.

Under these conditions of construction and of use of gas turbines, the building and use for small units has been excluded a priori for economical reasons.

BACKGROUND OF INVENTION

Technical problems cause decrease of the mechanical efficiency of gas turbine engines in relation to their size. Generally it may be said that small turbine engines of the same type are less efficient than big ones. But besides their use as prime movers, in which capacity they are rather inefficient, gas turbine machines can fulfil a range of other duties. As hot gas generators, for example their efficiency is very high, whilst other roles include blowers, compressors, combined heaters and compressors. as well as many other applications. It is in these duties, because of compactness. high efficiency, reliability, and long service life combined with a multi fuel capacity that gas turbines can provide an attractive alternative solution to existing installations.

For all these reasons, it would be highly desirable to have small gas turbine units - mainly for the production of hot gases for industrial - purposes which should be produceable in reasonably large series, at reasonable cost, with proper spare parts availability.

It is therefore the object of this invention to provide means for producing low cost gas turbines by providing a design, adapted for production of a versatile configuration of gas turbines from mass produced standard components, so called modules.

We believe to have found a surprisingly simple, but - as thorough investigation has shown - a yet satisfactory solution to produce gas turbines of small or medium capacity in a way which allows application of serieswise manufacture of the integral constituents of the turbines

and thereby not only to considerably reduc the initial cost thereof, but also to be in a position to supply from stock a requested gas turbine within a short time from its having been ordered by a customer.

SHORT SUMMARY OF DISCLOSURE

Accordingly the present invention proposes to produce several modules, each of which can be produced in a few standard sizes, the modules are subsequently - when need arises - assembled to form a gas turbine unit answering to the requirements of an individual case.

The main modules which when modularily assembled constitute the gas turbine unit would be:

a) the combustion module

b) the turbo module

c) the supply module

d) the control module.

These four modules are interconnected by appropriate connections, including fuel conduits, as well as electrical leads and the necessary mechanical connecting and fastening means.

The combustion module is intended to be fed with fuel and air and has an air inlet port and air outlet port for combustion gases which is ready for attachment of connections as may be required.

The turbo module is intended to transfer created energy to the flow of air or gas passing through the compressor.

The basic idea of this invention resides therein that the turbine is no longer built up as a compact, so to say self contained unit, but is assembled from constituent parts which are interconnected - according to need - by appropriate connecting conduits.

In this way the constituent parts of a gas turbine can be produced in a few standard dimensions and kept in storage to be assembled and connected with one another whenever required. Needless to say that assembling would take only a small fraction of time as compared with the conventional method of building the parts and assembling them at the same time.

The invention thus provides a complex of basic modules, which, by means of interconnection by basic conduits, as will be described below, can be integrated into various gas-turbine machines or systems.

Every module is free standing and self contained, meaning, that it can perform all its assigned functions without regard to its geometrical or physical position in relation to other parts of the machine, as long as it is properly connected by means of conduits to the other modules of the machine.

DESCRIPTION OF PREFERRED EMBODIMENT

The invention will now be described with reference to the accompanying schematical drawings which illustrate the different modules in purely schematical drawings, Figs. 1 - 12 as will be explained in detail in the following.

Turning first to Fig. 1 showing the combustion module.

Function of combustion module is to receive air and fuel and produce combustion gases accordingly to received signals.

Schematic symbol of combustion module is (12).

Combustion module consists of combustion chamber (1)/equipped contained in pressure vessel 1' with inlet air connection (2) and combustion gases outlet connection (3).

Combustion module is equipped with ignition device (4), fuel injecting or inserting means (5) and fuel control valves (6).

Fuel control valves (6) are equipped with appropriate fuel connections (7) and fuel signal connections (8).

Ignition device is equipped with ignition connection (9), combustion module can be equipped with mounting attachments or legs (13) as options.

Pressure and temperature measuring connections (14) are optional.

It should be observed that the fact of introduction of modules and connecting means makes it possible to produce the parts in the way indicated and assemble them at time of need and thus produce the gas turbine of the type and dimension dictated by local conditions and requirements of the purpose to which the turbine is to be put.

Supply module - Figure 2.

The function of supply module is to receive oil, fuel and electricity from their sources by means of appropriate connectors and supply them to other modules in physical conditions necessary for operation.

Schematic symbol of supply module is (40).

The supply module consists of following systems mounted together: fuel supply, oil supply, ignition, module drive.

Auxiliary supply systems (17) and connections (18) are optional.

The fuel supply system consists of fuel inlet connection (20), fuel filter (21), fuel pump (22), fuel pressure regulator (23), fuel return connection (24), fuel pressure gage or transducer (25) , fuel pressure outlet connection (26).

The oil supply system consists of oil inlet connection (27), oil pump (28), oil filter (29), oil pressure regulator (30), oil return connection (31), oil pressure gagge or transducer (32), oil high pressure connection (33), and oil low pressure connection (34).

The ignition system consists of electrical power connection (35), ignition generator (36), ignition connection (37).

The module drive (38) provides mechanical energy for pumps (22) and (28), and for ignition generator (35).

Optionally the supply module may also include an oil tank (39) but this is not mandatory.

The drive (38) is equipped with energy connection (15) and control connection (16).

Turbo module - Figure 3.

The function of the turbo module is transfer - according to demands of machine - part or all of turbine gases energy to air or gas flowing through compressor.

Schematic symbol of turbo module is (55).

The turbo- module consists of compressor wheel (54) and gas turbine wheel (41) connected by a common shaft (42) running in bearings (43).

The housing (51) and gas turbine housing (52) are connected by bearing housing (44).

The turbo module is equipped with compressor inlet connection (45), compressor outlet connection (46), turbine gases inlet connection (47), turbine gases outlet connection (48), oil inlet connection (49), and oil outlet connection (50).

Bearing housing (44) may be equipped with optional mounting pads (56).

Rotary velocity transducer connections (53) and turbine inlet and outlet transducer connections (54) are optional.

Control Module - Figure 4.

The control module consists of all control systems necessary for operating the machine and is equipped with appropriate signal (input) and command (output) connections. Additional to above, the control module is equipped with control connections, manual (switches, potentiometers, valves) or remote (appropriate input-output interfaces), and necessary gages and indicators. In addition to above, control module includes automatic safety override logic for overspeed, over-temperature, low oil pressure etc. Basic functions performed by control module are: start-stop, fuel (power) control, oil system control, ignition system control.

Schematic symbol of control module is (57).

Turbo-mechanical module - Figure 5.

The function of the turbo-mechanical module is to transfer, according to the demands of machine, part or all of the energy of the gases flowing through the turbine, to the mechanical connection 61.

Schematic symbol of turbo-mechanical module is (72).

The turbo-mechanical module consists of gas turbine (60), equipped with mechanical connection (61).

The gas turbine consists of a turbine wheel (61), turbine housing (62), turbine gases inlet connection (63), turbine gases outlet connection (64), turbine shaft (65), turbine bearings (66), and bearing housing (67).

Mechanical transmission (68) and mounting pads (69) are optional.

Bearing housing (67) and mechanical transmission (68) are equipped with oil inlet connections (70) and oil outlet connections (71).

Variable heat exchanger module - . Figure 6.

Function of variable heat transfer module is variable heat transfer from heating media to heated media according to command of control module.

Schematic symbol of variable heat-transfer module is (90).

Variable heat exchanger module consists of appropriate heat exchanger equipped with valve (81) controlling by-pass (82).

Module is equipped with appropriate inlet connections for heated media (83) heating media (84), outlet connections for heated media (85) and heating media (86), appropriate temperature transducer connections (87), valve signal connections (88), and valve power connections (89).

Auxiliary mixing module - Figure 7.

Function of auxiliary mixing module is to add and mix gases flowing through module with gases, liquids or solids supplied by supply module in amounts and conditions imposed by command module.

Schematic symbol of auxiliary mixing module is (97).

Auxiliary mixing module consists of mixing chamber (91), equipped with gas inlet connection (92), gas outlet connection (93), and means of injection (94).

The means of injection are equipped with supply connection (95) and control connection (96).

Starting module - Figure 8.

Function of starting module is to pump air through the machine in period of start-up to enable it to reach operating, self-sustaining parameters as ordered by control module IV.

Schematic symbol of start-up module is (108).

Starting module is small gas-jet pump equipped with air inlet connection (100), air outlet connection (101), gas inlet connection (102), gas nozzle (103), mixing chamber (104), diffuser (105) and gas valve (106) with control convection (107).

Basic conduits, their list and their schematic description are drawn in Fig. 9.

As has already been stated, gas turbine machines and systems are created according to this invention, by connecting basic modules by basic conduits.

Size, length and form of conduits are, according to this invention, not limited, as long as there is no appreciable change in physical parameters of the medium, transmitted by the conduit, between its input and output ends.

Basic modules and basic conduits are built in few sizes having different standard capacities. The modules of same function and same or different sizes can be connected in parallel by means of basic conduits and function as one bigger module of same function. In this way, gas turbine machines and systems of practically any size and configuration can be built from a few sizes of basic modules and basic conduits. As previously explained, the geometrical relation and position between modules is not important to the functioning of the modules, as long as the modules are properly connected by the proper connections.

This unique property of the invention is of utmost importance, especially from an economical and production point of view; it becomes possible to produce a limited number of sizes of basic modules in great quantity, quickly and at minimum cost. At the same time, the invention makes it possible to create from those parts a range of gas turbine machines in practically unlimited numbers of types and dimensions.

To illustrate the advantages of the invention a few possible embodiments of the invention are presented.

First embodiment - hot gas generator. This hot gas generator and conditioner is described in schematic diagram and descriptive form in Figure 10.

Schematic diagram 10a depicts modules (by symbols as described above) and their connection by basic conduits.

In descriptive form supply and control modules are ommited, as being installed in different location: a possibility unique to this invention.

In Fig. 10, ambient air enters air inlet of turbo module by means of module inlet 110 and leaves by module compressor outlet 112. Between compressor outlet 112 and combustion module inlet 113 the air passes starting module 111. Air is heated in combustion module by combustion of fuel supplied by injector controlled by valve 114 and ignited device 116. Hot air and combustion products leaves combustion module by combustion module outlet connection connected by conduit 118 to turbine inlet connection of the turbo module.

Hot air and combustion products drive turbine wheel of turbo module which in turn drives compressor wheel of turbo module. In this manner by connecting five basic modules we produced working gas turbine machine - hot gas generator. The hot air and combustion products flow from gas generator to auxiliary mixing module 124 and there are conditioned - accordingly to command of control module. In this way we have generator of hot conditioned gases.

By replacing of mixing module by turbo module and its oil conduits and one pneumatic conduit, transforms this machine into second embodiment of the invention - turbo-air compressor.

Schematic diagram and descriptive form of this machine are depicted in Fig. 11.

The machine works exactly as described before, except that combustion gases are divided and connected to two turbo-modules instead of one. One of turbo-compressor modules works as before, the difference being that part of the compressed air is directed to air inlet of second turbo-compressor module by means of appropriate pneumatic conduits. Compressor of second turbo-module, driven by its turbine, by the combustion gases of the combustion module - further compresses air from the first turbo-compressor.

In this manner, by the addition of one basic module and a few basic conduits, we created a different machine - a self-propelled turbo-air compressor.

Alternatively, by addition of turbo-mechanical module to system described in Fig. 10, we create yet another machine - a gas turbine engine giving mechanical energy output, this being third possible embodiment of the invention.

Schematic diagram and descriptive form of this machine are depicted in Fig. 12. In this embodiment, part of combustion gases, produced as described in first embodiment of the invention, is transferred through appropriate connector to gas turbine inlet of turbo-mechanical module. The energy of those transferred gases is extracted from them by turbo-mechanical module turbine wheel (61), converted to mechanical energy and by means of turbine shaft (60) transmitted to mechanical connection (61).

In Fig. 12, mechanical connection is connected further to reducing gear and mechanical energy converter as example of possible specific configuration.

It should be observed that the fact of introduction of modules and connecting conduits makes it possible to produce the parts in the way indicated and assemble them at time of need and thus produce the gas turbine of the type and dimension dictated by local conditions and requirements of the purpose to which the turbine is to be put.

CLAIMS:

1. The method of producing a gas turbine by prefabricating modules of the constituent parts of a gas turbine and assembling such modules by connecting them with connecting conduits of a length and kind according to the needs of the assembly being created and in consideration of the purpose to which the turbine is to be put.

2. The method of claim 1, characterised thereby that the individual modules are positioned relative to one another and at distances from one another, as determined by the future use of the turbine.

3. The method of claim 1 or 2, characterised thereby that there are connected with one another the combustion module, the turbo module and the supply module.

4. The method of claim 3, characterised thereby that to the said three modules a control module is added.

5. The method of producing a gas turbine, substantially as hereinbefore described with reference to the accompanying drawings.